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   US 4276541

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   G3T
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(54) **Electronic Equipment with Touch Switches**

(57) Electronic equipment with touch switches (12) exchanges data between an internal memory (33) thereof and an external device (28) by means of the touch switches (12) which are mounted on the case of the equipment, and by means of a modem (2) which adopts the tone burst system and which utilizes a contact capacitance component between the touch switches and conductive rubber contacts on the modem.
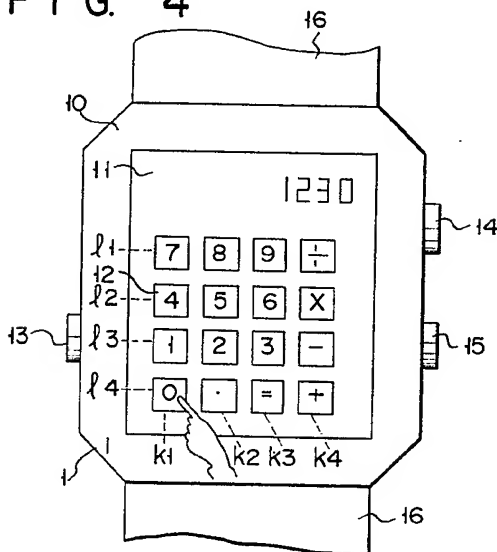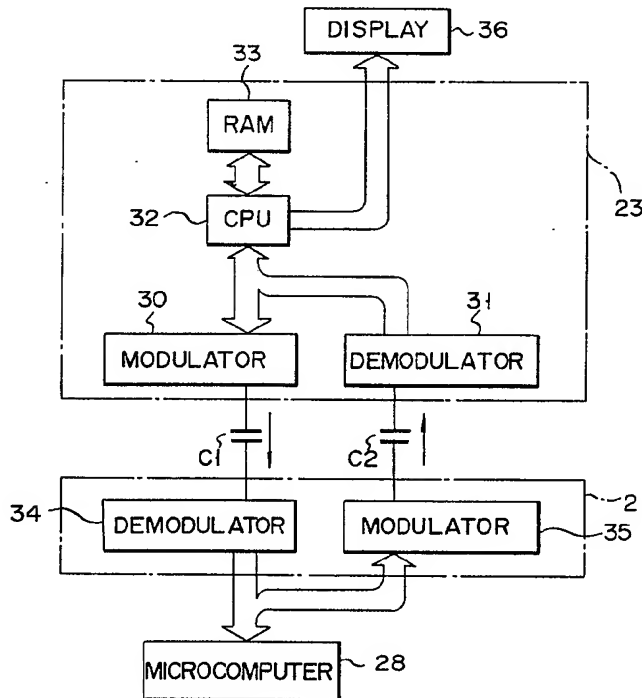
F I G. 4

F I G. 9
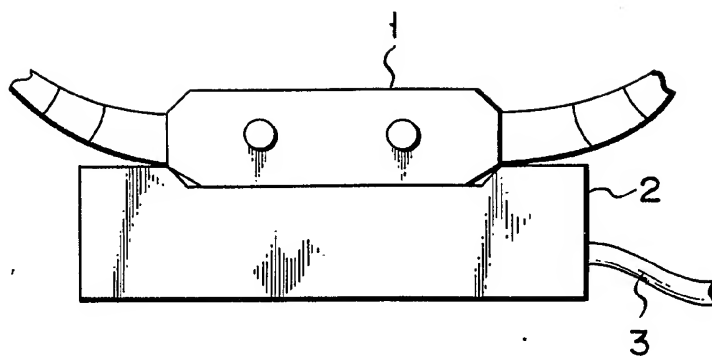
The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.
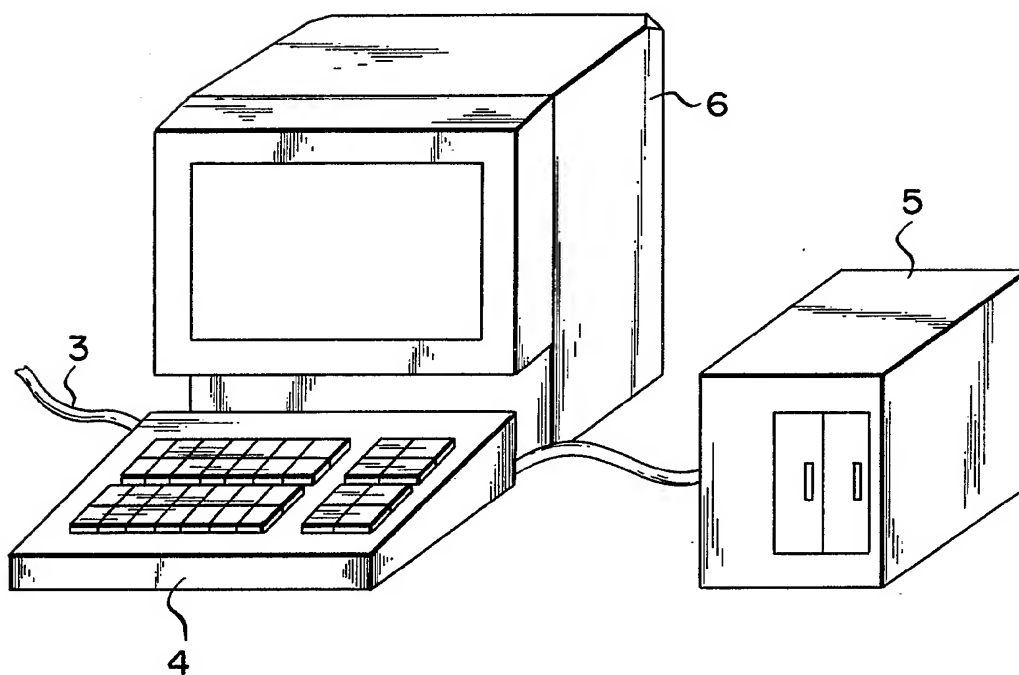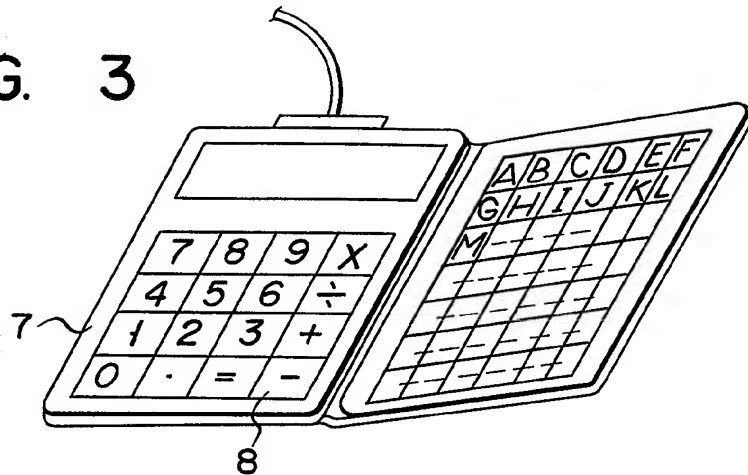
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F I G. 1

F I G. 2

FIG. 3

FIG. 4

F I G. 5

F I G. 6

F I G. 7

F I G. 8

F I G. 9

2137733

F I G. 10

V_DD

G∘— [40 AND gate] —C_C—|(— 41 ⬎ R2 44 ▷— ∘ OUT

C

42 R1 43 CI

f 30, 35

34, 31

F I G. 11

G

A

B

C

OUT
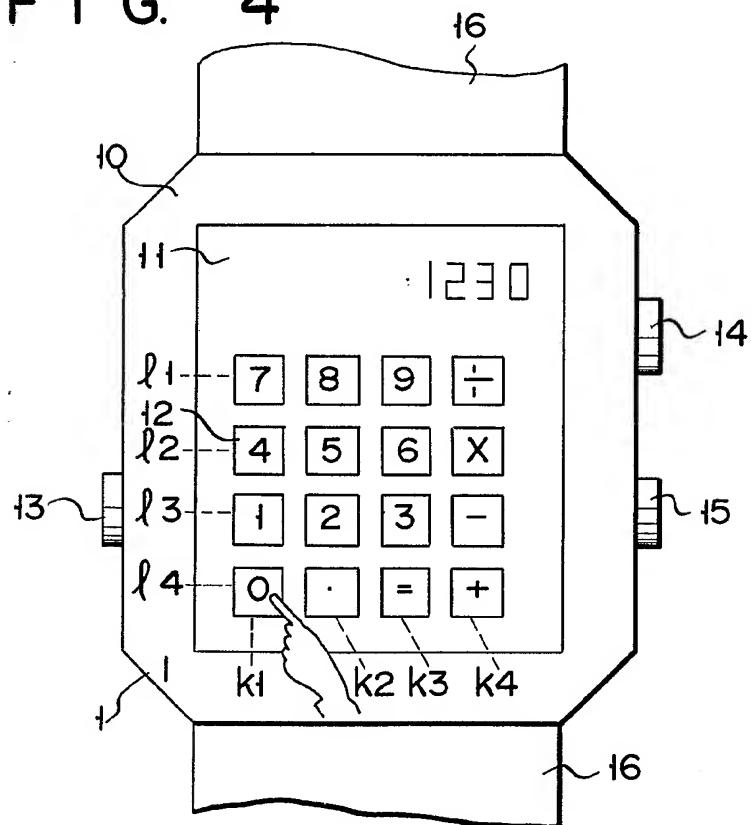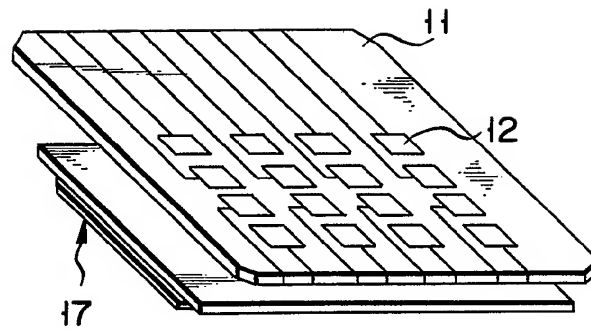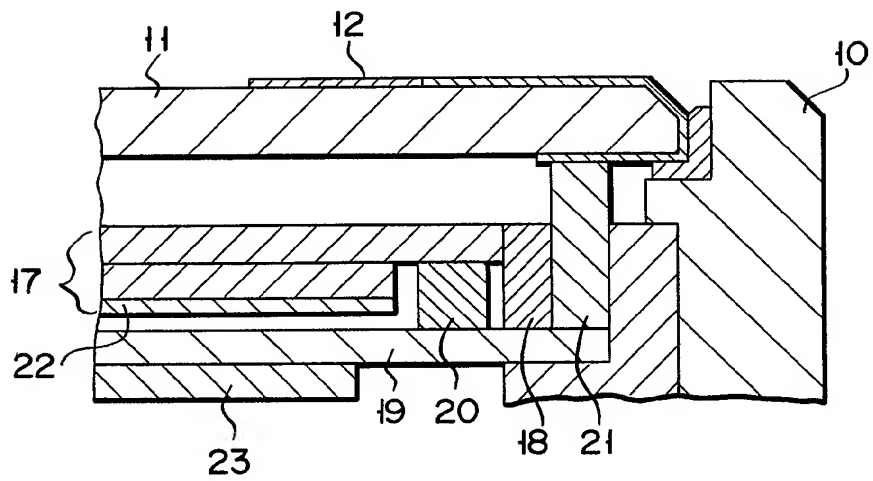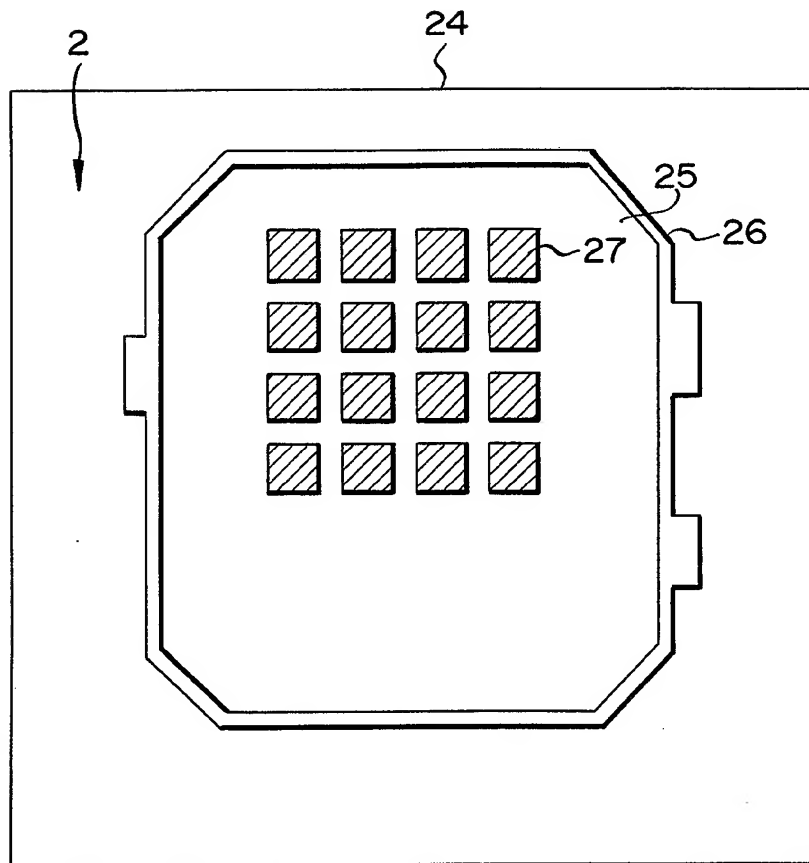
SPECIFICATION
Electronic Equipment with Touch Switches

The present invention relates to electronic
equipment which has a plurality of touch switches
5 mounted on a main body, which contains a
memory and which exchanges data with an
external device.

With the rapid developments in the LSI
technique, an ROM (read-only memory) or a RAM
10 (random-access memory) of a large capacity is
frequently assembled in electronic equipment
such as electronic wrist watches, word processors
or electronic calculators. Such equipment with a
ROM or RAM can perform their original function
15 as well as the additional function of displaying
memo data preset in the ROM or RAM as needed.
Data is exchanged between the RAM in the
electronic equipment and the external device
either by mechanical or nonmechanical coupling.
20 Data exchanged by mechanical coupling is
disclosed, for example, in U.S. Patent No.
4,165,605 wherein terminals of the electronic
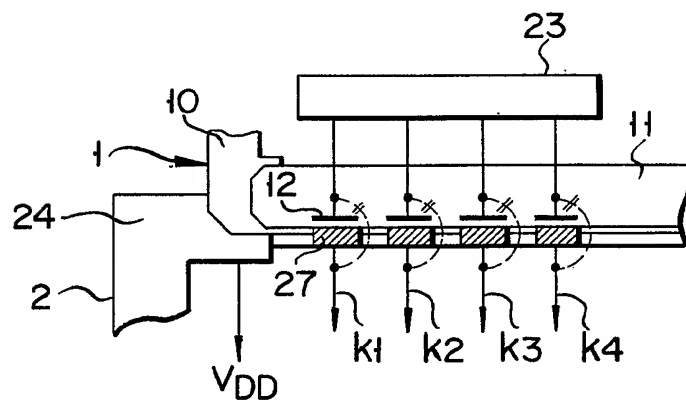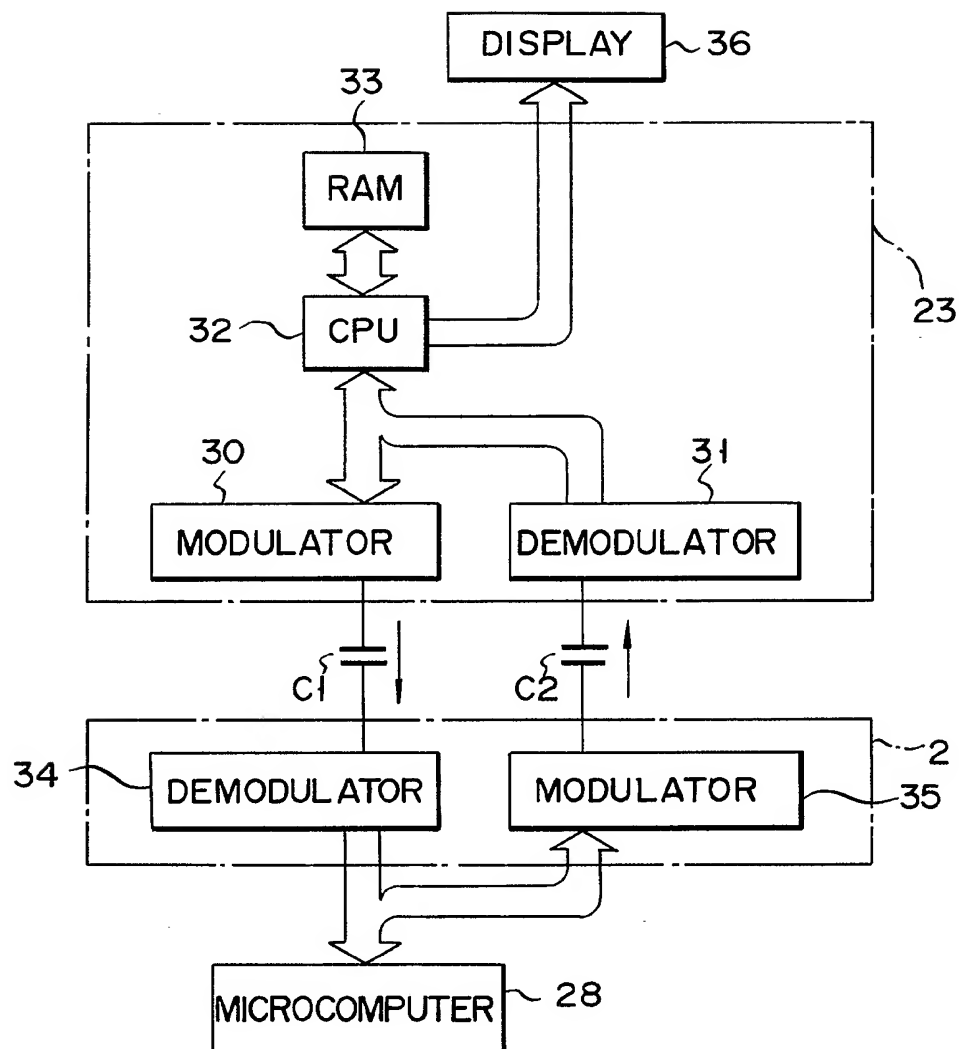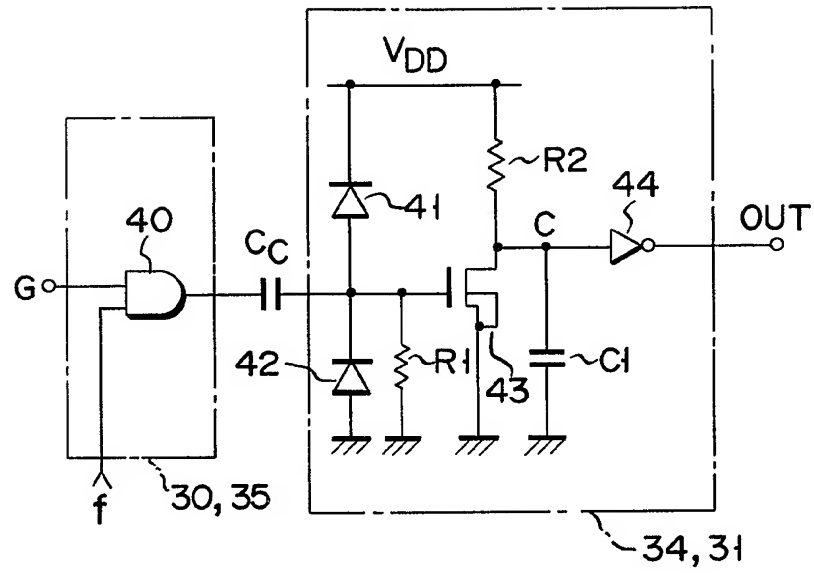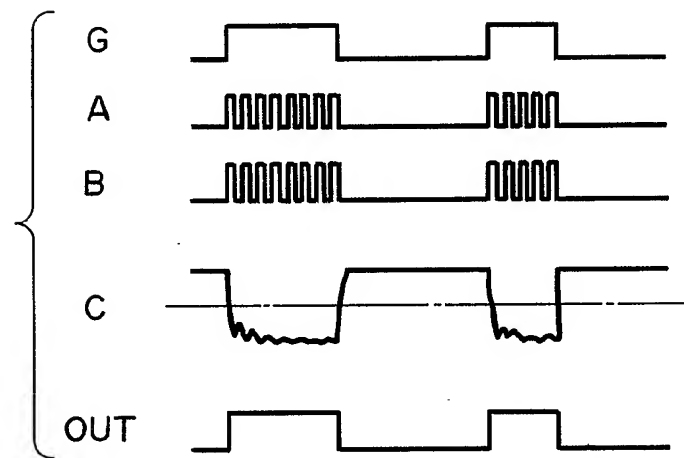equipment and the external devices are
connected to each other. Data exchanged by
25 nonmechanical coupling can be achieved by
magnetic coupling as disclosed, for example, in
U.S. Patent No. 4,023,344.

However, in the former case, when for
example, the electronic equipment is an electronic
30 wrist watch which is mechanically coupled to a
reference clock device for time correction, the rear
cover of the wrist watch must be able to open to
allow access to the terminal. The terminal of the
wrist watch can then be connected to the
35 terminal of the external device. This is a complex
operation and presents the problem of poor
waterproofing since the watch's rear cover must
be opened each time access to the terminal is
made.
40 On the other hand, in the latter case, as in U.S.
Patent No. 4,023,344, magnetic or optical data
exchange requires the use of a magnetic or
optical sensor, resulting in a bulky apparatus.

It is an object of the present invention to
45 provide electronic equipment with touch switches
capable of data exchanging data easily with an
external device by means of touch switches and
which uses mechanical coupling.

In order to achieve the above object of the
50 present invention, there is provided electronic
equipment with touch switches for exchanging
data with an external device, comprising:
(a) a case of said electronic equipment;
(b) an electronic circuit which is arranged
55 inside said case which has at least one memory
circuit and a control circuit for controlling said
memory circuit;
(c) touch switch means arranged on the outer
surface of said case which is electrically coupled
60 to said electronic circuit, said touch switch means
serving as the input switches for controlling said
electronic circuit when it is in contact with a
human body, and in which the positions of said
switches correspond to the positions of the

65 connecting terminals for exchanging data with
said external device; and
(d) a writing means for supplying data in said
memory circuit to said touch switch means in
order to write the data from said touch switch
70 means in said memory circuit so as to exchange
the data with said external device.

The electronic equipment with touch switches
having the above configuration exchanges data
between the memory of the electronic equipment
75 and the external device by means of the touch
switches arranged on the main body and by means
of a modem which adopts the tone burst system
and which utilizes a contact capacitance
component with the external device. The
80 electronic equipment of the present invention can
thus allow manual data to be input by means of
touch switches while assuring that data is
exchanged by the mechanical coupling.

This invention can be more fully understood
85 from the following detailed description when
taken in conjunction with the accompanying
drawings, in which:

Figure 1 is a view of an electronic wrist watch
as an example of electronic equipment according
90 to the present invention in the state wherein the
watch is mechanically coupled to a modem;

Figure 2 is a schematic perspective view
wherein the external device of the present
invention is applied to a word processor;
95 Figure 3 is a schematic perspective view
wherein the external device of the present
invention is applied to an electronic calculator;

Figure 4 is a plan view of an electronic wrist
watch according to another embodiment of the
100 present invention;

Figure 5 is a perspective view showing the
configuration of a glass case with touch
electrodes, and the liquid crystal display of the
electronic wrist watch shown in Figure 4;
105 Figure 6 is a cross-sectional view of the main
part of the electronic wrist watch shown in Figure
4;

Figure 7 is a plan view of the modem used in
the embodiment of the present invention;
110 Figure 8 is a diagram showing the electrical
connection between the electronic wrist watch
and the modem;

Figure 9 is a block diagram showing the circuit
configuration according to the embodiment of the
115 present invention;

Figure 10 is a circuit diagram of a modem
which uses the tone burst system according to
the embodiment of the present invention; and

Figure 11 is a timing chart showing the
120 waveforms of the respective parts of the circuit
shown in Figure 10.

The preferred embodiment of the present
invention will now be described with reference to
the accompanying drawings.
125 Figure 1 shows an electronic wrist watch as an
embodiment of electronic equipment according to
the present invention. In the state shown in Figure
1, an electronic wrist watch 1 is connected to a
modem (modulator/demodulator) 2 which in turn

is connected to the touch switches of the watch 1. The modem 2 is connected to an external device such as a microcomputer through a cable 3 so as to allow data to be exchanged between
5 the watch 1 and the microcomputer.

Figure 2 shows a case wherein an external device is a word processor which consists of a key input device 4, a floppy disk device 5, and a CRT device 6. The key input device 4 is connected to
10 the modem 2 so as to allow data to be exchanged between the electronic wrist watch and an external device.

Figure 3 shows an electronic calculator 7 as the external device of the present invention. The
15 electronic calculator 7 is connected to the modem 2 so as to allow data to be exchanged between the memory of the electronic calculator 7 and the electronic wrist watch 1.

Electronic equipment with touch switches
20 according to the present invention has a built-in memory. It can exchange data with an external when it is connected to the external device by a modem.

An embodiment wherein an electronic wrist
25 watch is the electronic equipment of the present invention will now be described with reference to Figures 4 to 11.

An electronic wrist watch 1 shown in Figure 4 has a cover glass 11 on the upper surface of a
30 case 10, and a rear cover (not shown) on the lower surface. 16 transparent touch switches 12, including ten keys and function keys, are arranged on the cover glass 11. Three separate switches 13, 14 and 15 and a wrist band 16 are arranged
35 at the ends of the case 10.

Figure 5 shows the positional relationship between the cover glass 11 of the wrist watch 1 on which the touch switches 12 are mounted, and a liquid crystal display 17 arranged below the
40 cover glass 11. Figure 6 is a cross-sectional view of the wrist watch 1.

A circuit board 19 is fixed by a housing 18 in the case 10. A conductive interconnector 20 electrically connects the liquid crystal display 17
45 and the circuit board 19. Another conductive interconnector 21 electrically connects the circuit board 19 and the cover glass 11 with the touch switches 12 thereon. A reflecting plate 22 is arranged at one side of the liquid crystal display
50 17 which is separated from the circuit board 19. The other side of the liquid crystal display 17 is also separated from the cover glass 11. An LSI chip 23 is mounted on the rear surface of the circuit board 19 and is electrically connected to
55 the liquid crystal device 17 and the touch switches 12.

In the electronic wrist watch 1, as shown in Figure 4, numbers (0 to 9), function symbols (+, −, ×, ÷, and =), the decimal point and the like are
60 displayed by the liquid crystal device 17 at the positions respectively corresponding to the touch switches 12. Thus, the liquid crystal device 17 clearly indicates the positions of the transparent touch switches 12. When a touch switch or
65 switches 12 are operated, the corresponding

input is supplied to the LSI chip 23 through the conductive interconnector 21. The entry data, the calculation result and the like is displayed above the liquid crystal device 17. Since control of the
70 electronic circuit by means of touch switches is well known, the detailed circuit configuration for this purpose will not be described.

The modem 2 has the configuration as shown in Figure 7. A recess 25 is formed in the upper
75 surface of the case's main body 24 of the modem 2. The recess 25 is slightly larger than the cover glass 11 of the electronic wrist watch 1. When the electronic wrist watch 1 is received in the recess 25, the watch 1 is positioned by a frame
80 26. Sixteen conductive rubber members 27 are arranged at those positions of the recess 25 which correspond to the respective touch switches 12 of the electronic wrist watch 1. A modulator and demodulator of the modem 2 (to
85 be described later) are connected to these conductive rubber members 27.

When the electronic wrist watch 1 is received in the recess 25 of the modem 2 and the sixteen touch switches 12 contact the sixteen conductive
90 rubber members 27, a contact capacitance component is generated. Data is exchanged through the modulator or demodulator utilizing this contact capacitance component.

Figure 8 shows the electrical connection
95 between the electronic wrist watch 1 and the modem 2. The contact capacitance component is indicated by a capacitor symbol. A high voltage VDD is applied to the case's main body 24 of the modem 2, and a low voltage is applied to the
100 touch switches 12. The touch switches 12 which are arranged in a 4×4 matrix are connected to a microcomputer 28 as an external device through signal lines k1 to k4 for each column of the matrix.

105 The circuit including the LSI chip 23 assembled in the electronic wrist watch 1 and the modem 2, and the connection between the circuit and the microcomputer 28 as the external device will now be described with reference to Figure 9. (In Figure
110 9, the circuit for initiating calculation upon depressing the touch switches is not shown).

A modulator 30 and a demodulator 31 inside the LSI chip 23 together constitute a modem in the electronic wrist watch 1. Data read out from a
115 RAM (random-access memory) 33 is supplied to the modulator 30 through a CPU (central processing unit) 32. The modulator 30 converts the input data (8-bit parallel data) into analog serial data and supplies it to, for example, a total
120 of 8 touch switches 12 in the first row l1 and the second row l2 as shown in Figure 4. In this case, the first through fourth bits of the 8-bit parallel data are respectively supplied to the touch switches 12 of the first column k1, second
125 column k2, third column k3 and fourth column k4, of the first row l1. The fifth through eighth bits of the 8-bit parallel data are respectively supplied to the touch switches 12 of the first column k1, second column k2, third column k3 and fourth
130 column k4, of the second row l2. The signals

supplied to these eight touch switches 12 are
supplied to a modulator 34 of the modem 2
through a contact capacitance component Cc
(Figure 10) which is formed between these touch
5   switches 12 and the corresponding eight
conductive rubber members 27 of the modem 2
at the side of the microcomputer 28. The
demodulator 34 converts the input signals into
corresponding 8-bit digital parallel data and
10 supplies it to the microcomputer 28 through the
cable 3.
The demodulator 31 of the LSI chip 23 is
connected to the CPU 32 as shown in the
drawings. The demodulator 31 receives the 8-bit
15 parallel data from the microcomputer 28 through
the cable 3, a modulator 35 of the modem 2, and
the contact capacitance Cc (Figure 10) which is
generated between the eight conductive rubber
members 27 on the modem 2 and the
20 corresponding eight touch switches 12 on the
cover glass 11. In other words, the modulator 35
serves to convert the 8-bit parallel data from the
microcomputer 28 into analog serial data. More
specifically, the conversion signals from the
25 modulator 35 which correspond to the first
through fourth bits of the 8-bit parallel data from
the microcomputer 28 are supplied to those
conductive rubber members 27 which correspond
to the touch switches 12 of the first column k1,
30 second column k2, third column k3 and fourth
column k4, respectively, of the third row I3.
Conversion signals from the modulator 35 which
correspond to the fifth through eighth bits of the
8-bit parallel data are supplied to those
35 conductive rubber members 27 which correspond
to the touch switches 12 of the first column k1,
second column k2, third column k3 and fourth
column k4, respectively, of the fourth row I4. As a
result, the serial data input to the demodulator 31
40 through the contact capacitance component Cc of
the eight touch switches 12 of the third and
fourth rows and the corresponding eight
conductive rubber members 27 is converted into
8-bit parallel data. The 8-bit parallel data from the
45 demodulator 31 is written in the RAM 33 through
the CPU 32.
The CPU 32 is a microprocessing circuit for
controlling the clock function, the calculation
function, and the like, of the electronic wrist
50 watch 1. The CPU 32 also controls the read and
write operation of data output and input into the
RAM 33. A display 36 is connected to the CPU 32
and is controlled thereby. The display 36
comprises a liquid crystal display. It displays the
55 time data and calculation result data stored in the
RAM 33 and various data supplied from the
microcomputer 28. The modulator 30 and 35,
and the demodulators 31 and 34 have the
configurations as shown in Figure 10. Each
60 modulator/demodulator pair is connected through
the contact capacitance component Cc according
to the tone burst system. More specifically, the
modulator 30 or 34 comprises an AND circuit 40
with a gate which receives a signal G (Figure 11)
65 to be transmitted and a square wave signal f.

Meanwhile, the demodulator 31 or 34 comprise a
series circuit of diodes 41 and 42 for limiting the
amplitude of the power supply voltage. The
output terminal of the AND gate 40 of the
70 corresponding modulator 30 or 35 is connected
to the node between the diodes 41 and 42
through the contact capacitance component Cc.
The aforementioned node is connected to the
gate of an n-MOSFET 43 and is also grounded
75 through a resistor R1. The source of the n-
MOSFET 43 is grounded, and the drain thereof
receives a voltage VDD through a resistor R2. The
cathode of the diode 41 also receives the voltage
VDD. The node of the drain of the n-MOSFET 43
80 and the resistor R2 is connected to an inverter 44
and is also grounded through a capacitor C1. In
the modulator 30 or 35, the square wave signal f
supplied to one input terminal of the AND circuit
40 is switched by the signal G, causing it to be
85 transmitted and produced as a tone burst signal
A.
The tone burst signal A is supplied to the
demodulator 34 or 31 through the contact
capacitance component Cc whose amplitude is
90 limited by the diodes 41 and 42 to become a
signal B (Figure 11) which is supplied to the gate
of the n-MOSFET 43 to turn it on or off. At this
time, at the drain of the n-MOSFET 43, wave
detection is performed and determined by the
95 time constant of the capacitor C1 and the resistor
R2. A signal C having the waveform shown in the
drawing is supplied to the inverter 44 and is then
sliced. The inverter 44 produces a signal which
corresponds to the waveform of the input signal
100 G, and which is obtained by inverting the signal C.
The actual mode of exchanging data using the
modulators/demodulators of a configuration
having the tone burst system as described above
will now be described with reference to the case
105 of data exchanged between an electronic wrist
watch as the electronic equipment, and a
microcomputer as the external device.
Assume that memory data is to be written in
the RAM 33 of the electronic wrist watch 1 from
110 the microcomputer 28. First, the electronic wrist
watch 1 is fitted in the recess 25 of the case main
body 24 of the modem 2, with the upper surface
of the watch 1 facing the bottom surface of the
recess 25. Thus, the sixteen touch switches 12 on
115 the case 10 respectively contact the
corresponding sixteen conductive rubber
members 27 on the modem 2.
The power of the modem 2 is turned on. Power
is constantly supplied from a cell to the electronic
120 wrist watch 1. Power is also supplied to the
microcomputer 28. Data is input by operating the
keys of the microcomputer 28. In this case, write
data is produced from the microcomputer 28 in
the form of 8-bit parallel data and is supplied to
125 the modulator 35 of the modem 2 through the
cable 3. The modulator 35 converts the input data
into analog serial data and supplies the data to a
total of eight conductive rubber members 27
which correspond to the touch switches 12 of the
130 first to fourth columns k1 to k4 of the third and

fourth rows I3 and I4. Accordingly, since a contact capacitance component Cc is formed between each of these eight conductive rubber members 27 and the corresponding touch switch 12 on the
5 cover glass 11, the applied data is supplied to the demodulator 31 in the electronic wrist watch 1 through the corresponding contact capacitance component Cc. The data is thus converted into 8-bit parallel data and is supplied to and written in
10 the RAM 33 through the CPU 32. In this manner, the data supplied from the microcomputer 28 is sequentially written in the RAM 33.

The user of the electronic wrist watch 1 can cause the display 17 to display data stored in the
15 RAM 33 such as names, addresses, and telephone numbers, and so on. In order to perform this display, the switches 13, 14 and 15 of the watch 1 are operated.

Assume now that many items of data in the
20 RAM 33 of the LSI chip 23 (e.g., the addresses and telephone numbers of peoples) are to be supplied to the microcomputer 28 in the alphabetical order. In this case, a predetermined keying operation of the microcomputer 28 is
25 performed to instruct readout of data from the RAM 33. Then, 8-bit parallel data is read out from the RAM 33 and supplied to the modulator 30 through the CPU 32. The modulator 30 converts the input 8-bit parallel data into analog serial
30 data, and supplies this serial data to a total of eight touch switches 12 of the first to fourth columns k1 to k4 of the first and second rows I1 and I2. Thus, a contact capacitance component Cc is formed between each of the eight touch
35 switches 12 and the corresponding conductive rubber member 27. The applied data is supplied to the demodulator 34 of the modem 2 through the respective contact capacitance components Cc. The demodulator 34 converts the input serial
40 data into 8-bit parallel data which is supplied to the microcomputer 28 through the cable 3 to be processed therein.

When the user of the watch 1 wants to store another name, address and telephone number in
45 the RAM 33, he enters this data in the microcomputer. Then, the current contents of the RAM 33 are supplied to the microcomputer which rearranges the contents including the new input data in alphabetical order. This reedited data is
50 rewritten in the RAM 33 of the watch 1. When the switches 13, 14 and 15 are operated, the new data including the name, address, telephone number and so on can be displayed by the display 36.

55 In the above embodiment, the data including the names, addresses and telephone numbers is exchanged. However, the data to be exchanged is not limited to such data. For example, data such as schedule data or memo data can be
60 exchanged. If the user of the watch is a salesperson, data about clients or other sales data can be written and later entered into the microcomputer. In this case, the circuit arrangement for supplying data from the
65 microcomputer to the wrist watch can be omitted.

In the embodiment described above, the touch switches 12 are arranged in a 4×4 matrix. However, the number of touch switches can be changed as needed. Furthermore, the data to be
70 exchanged need not be 8-bit data but may be, for example, 4-bit data. Although the present invention is applied to an electronic wrist watch, it can be similarly applied to other types of electronic equipment with touch switches. The
75 external device to be coupled to such electronic equipment is not limited to a microcomputer but may be other types of equipment capable of data exchange.

CLAIMS
80   1. Electronic equipment with touch switches for exchanging data with an external device, comprising:
(a) a case of said electronic equipment;
(b) an electronic circuit which is arranged
85 inside said case and which has at least one memory circuit and a control circuit for controlling said memory circuit;
(c) touch switch means arranged on the other surface of said case which is electrically coupled
90 to said electronic circuit, said touch switch means serving as the input switches for controlling said electronic circuit when it is in contact with a human body, and in which the positions of said switches correspond to the positions of the
95 connecting terminals for exchanging data with said external device; and
(d) writing means for supplying data in said memory circuit to said touch switch means in order to write the data from said touch switch
100 means in said memory circuit so as to exchange the data with said external device.
2. The equipment according to claim 1, wherein said touch switch means has a plurality of touch electrodes which have the positions
105 respectively corresponding to the positions of said connecting terminals to exchange the data of said external device.
3. The equipment according to claim 1, wherein said electronic circuit has a calculation
110 function, and said touch switch means is a calculation data entry and function switch.
4. The equipment according to claim 1, wherein said electronic circuit has a clock function with a memory storing time data.
115   5. The equipment according to claim 1, wherein said equipment is a wrist watch.
6. The equipment according to claim 1, further comprising display means for displaying the data in said memory circuit which is supplied through
120 said touch switch means.
7. The equipment according to claim 6, wherein said touch switch means is arranged above said display means.
8. Electronic equipment with touch switches
125 for storing data supplied from an external device in a memory circuit, comprising:
(a) a case of said electronic equipment;
(b) an electronic circuit which is arranged inside said case and which has at least said

memory circuit and a control circuit for controlling said memory circuit;

(c) touch switch means arranged on the outer surface of said case which is electrically coupled to said electronic circuit, said touch switch means serving as the input switches for controlling said electronic circuit when it is contact with a human body, and in which the positions of said switches correspond to the positions of the data transmitting terminals of said external device; and

(d) writing means for writing the data from said external device in said memory circuit through said touch switch means so as to receive the data from said memory circuit.

9. The equipment according to claim 8, wherein said touch switch means has a plurality of touch electrodes which has a position corresponding to the position of said data transmitting terminals of said external device.

10. The equipment according to claim 8, wherein said electronic circuit has a calculation function, and said touch switch means is a calculation data entry and function switch.

11. The equipment according to claim 8, wherein said electronic circuit has a clock function with a memory storing time data.

12. The equipment according to claim 8, wherein said equipment is a wrist watch.

13. The equipment according to claim 8, further comprising display means for displaying the data in said memory circuit which is supplied through said touch switch means.

14. The equipment according to claim 13, wherein said touch switch means is arranged above said display means.

15. Electronic equipment with touch switches for supplying data stored in a memory circuit to an external device, comprising:

(a) a case of said electronic equipment;

(b) an electronic circuit which is arranged inside said case and which has at least said memory circuit and a control circuit for controlling said memory circuit;

(c) touch switch means arranged on the outer surface of said case which is electrically coupled to said electronic circuit, said touch switch means serving as the input switches for controlling said electronic circuit when it is in contact with a

human body, and in which the positions of said switches corresponding to the positions of the data receiving terminals of said external device; and

(d) writing means for supplying the data from said memory circuit through said touch switch means to said external device.

16. The equipment according to claim 15, wherein said touch switch means has a plurality of touch electrodes which has a position corresponding to the position of said data receiving terminals of said external device.

17. The equipment according to claim 15, wherein said electronic circuit has a calculation function, and said touch switch means is a calculation data entry and function switch.

18. The equipment according to claim 15, wherein said electronic circuit has a clock function with a memory storing time data.

19. The equipment according to claim 15, wherein said equipment is a wrist watch.

20. The equipment according to claim 15, further comprising display means for displaying the data in said memory circuit which is supplied through said touch switch means.

21. The equipment according to claim 20, wherein said touch switch means is arranged above said display means.

22. The equipment according to claim 15, wherein said external device has memory means, and data stored in said memory means is written in said memory circuit through said touch switch means.

23. The equipment according to claim 15, wherein said external device has a key input section for data input.

24. The equipment according to claim 8, wherein said external device has memory means, and data stored in said memory means is written in said memory circuit through said touch switch means.

25. The equipment according to claim 8, wherein said external device has a key input section for data input.

26. An electronic equipment with touch switches, substantially as hereinbefore described with reference to the accompanying drawings.